

coming much less common, probably as a result of the custom among our shoe merchants of fitting the shoes longer.

The treatment of bunions may be divided into three phases. First there is the bursitis which responds to relief of pressure and hypertonic saline baths. The second stage is that of moderate exostosis of the head of the metatarsal with or without bursitis, requiring removal of the excrescence without interference with the joint. The third and most severe group is that with marked valgus deformity, necessitating surgical correction. The operation which I have found to be by far the most satisfactory

is that of resection of the proximal half of the proximal phalanx, with removal of the exostosis from the medial aspect of the head of the metatarsal. This procedure is used extensively in Liverpool and Birmingham. It produces a uniformly good result and enables the patient to return to his occupation at much the earliest moment of any surgical procedure.

In conclusion I would point out that in the alleviation of foot discomforts treatment should be as simple as possible, relieving the fundamental causes of the discomfort, and at the same time effecting return to normal by observing simple physiological principles.

### ACTINOMYCOSIS\*

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BECAUSE actinomycosis is rarely diagnosed, it is considered a rare disease. The result of such a conception is the missing of many cases, and an understanding of the disease which now lags far behind that of the other chronic granulomata.

Historically it may be considered to be as old as a fossil rhinoceros, in which sinus tracts in the jaw were deduced to be due to actinomycosis.<sup>1</sup> Although several isolated cases were reported before 1877, it was not until that year that Bollinger and Harz<sup>2</sup> isolated the organism from the jaw of an ox, and named it the "ray fungus" because of its radiate appearance. Wolff and Israel<sup>3</sup> cultivated the organism anaerobically in 1891 from a human case. The first human case recognized in Canada was under the care of the late Dr. James Bell,<sup>4</sup> at the Royal Victoria Hospital, Montreal, in 1900. Here Dr. A. G. Nicholls, then assistant-pathologist to the hospital, was able to demonstrate the fungus in scrapings from a persistent lumbar sinus of previously obscure origin. In 1902 Lignières and Spitz,<sup>5</sup> in the Argentine, found and differentiated an actino-bacillus in cattle; while Klinger<sup>6</sup> in 1912 observed the *Actino-mycetum comitans*, which constitutes much of the Gram-negative material in the granule. Naeslund<sup>7</sup> in Sweden has made a bacteriological classification of the numerous organisms, and has done illuminating work on the etiology. Last year Cope<sup>8</sup> published the first monograph in English on the subject.

The bacteriology is complicated by the large number of organisms which have been described, only a few of them being pathogenic to man, and none having any marked pathogenicity for laboratory animals. There is no generally accepted classification at present; and for the purposes of this paper I have arranged information from Topley and Wilson<sup>9</sup> based on Naeslund's

work. (This arrangement is found in Table I.) The anaerobic *Actinomyces bovis* of Wolff-Israel is the only one recognized by Colebrooke<sup>10</sup> as causing true actinomycosis, and the disease caused by *A. maduræ* he names paractinomycosis. There is some doubt as to the advisability of this distinction, and it might be better to adopt the term actinomycosis to include any disease caused by the genus actinomyces. It will be noticed that *A. graminis* (Harz) and *A. hominis* (Boestrom) have not been included in the Table, the reason being that they have never been generally accepted as pathogenic.

Because of Boestrom's<sup>11</sup> lengthy paper following his isolation of the organism, and the numerous aerobic strains found on grasses, grains, etc., it has been long and almost universally believed that the disease was contracted by chewing straw. All the recent opinion, however, leans towards the view that, as *A. bovis* of Wolff-Israel has never yet been found outside the animal body, and as most of the aerobic strains are saprophytic, the part played by chewing straw is only to make a wound and thus furnish a portal of entry into the body. Nevertheless, definitely aerobic species have been isolated from disease processes in man and animals, and have been brought together by Erikson.<sup>12</sup>

Many cases point to the mouth as the probable source of infection, of which three famous cases may be mentioned: (1) Israel<sup>13</sup> reported one where a fragment of carious tooth was found embedded in a focus of actinomycosis of the

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lung. (2) Judd's<sup>14</sup> case, which followed the extraction of a tooth. (3) Cope<sup>15</sup> reported a case of actinomycosis of the knuckle, which resulted from a blow that broke an antagonist's tooth. To this list I should like to add a case from the London Hospital. In 1934 a man aged 35 had an ulcer on the dorsum of his hand which looked somewhat like a gumma. He admitted the lesion had been caused by the bite of a

parently flourishes in hollows, the sites affected are usually the pockets around the teeth associated with periodontal disease requiring extraction, the salivary glands, the tonsillar crypts, and the appendix. The second method is by aspiration into the lungs, where the lesion may be due to either the anaerobic or the aerobic type. The third portal has already been illustrated, namely, direct inoculation through the skin.

TABLE I.  
ACTINOMYCES

	Name	Culture				Pathogenicity		
		Grows at	G.	Clubs	Granules	Man	Cattle	Laboratory animals
FUNGI								
I. Anaerobic.....	<i>A. bovis</i> Wolff-Israel	37° C.	+	Clubs	Granules	Cervico-facial, abdominal, thoracic, etc.	Jaw	Local reaction only.
II. Aerobic.....								
1. Non-acid-fast..	<i>A. maduræ</i>	20° C.	+	Clubs	Granules	Madura disease.	....	None
2. Acid-fast.....	<i>A. asteroides</i>	20° C.	+	None	None	Pulmonary disease.	....	Pseudo-tuberculosis in monkeys, rabbits and guinea-pigs.
BACILLI								
I. Aerobic non-acid-fast.....	1. <i>Actinobacillus ligniersi</i>	20° C.	-	Clubs	Granules	....	Woody tongue, soft tissues of head, neck, and lymph glands.	Guinea pigs die in 7 days.
	2. <i>Actinomyces comitans</i>	37° C.	-			Usually accompanies <i>A. bovis</i> .		

prostitute. The Wassermann reaction was negative; a biopsy showed actinomyces granules, while in culture the organism grew aerobically. This case is, therefore, classed by Colebrooke as paraactinomycosis.

Naeslund<sup>16</sup> found anaerobic, pathogenic, actinomycotic organisms in the mouths of normal people. Further, he found that when tartar and salivary calculi were decalcified a stroma remained consisting of interwoven actinomycotic filaments. Positive growths were obtained on media of sterilized saliva; some of these were aerobic, but the majority were anaerobic. Organisms definitely recognized as actinomyces were frequently found by other investigators in the mouth and pharynx, and may or may not have pathogenic significance. It follows that a common habitat of these organisms is the mouth.

Probable portals of entry for these pathogenic organisms into the body are, firstly, by way of the alimentary tract. As the ray fungus ap-

The pathogenicity of the various actinomycotic organisms is still a debatable topic for bacteriologists, and, as has been stated above, laboratory animals seldom show anything more than a mild local reaction, or at best abscess formation. A possible explanation of this lack of observed pathogenicity is given by Hassegawa *et al.*<sup>17</sup> In their experimental work, using puppies, they only obtained progressive changes with mixed infections, *e.g.*, of actinomyces with *Staph. aureus*, *S. viridans*, and *Spirochaeta dentium*, the symbiotic effect being much greater than that produced by any of the organisms singly. This hypothesis offers a promising lead for further investigation, as the importance of mixed infection must be assessed in each individual case.

Two main features emerge from a study of any series of cases—the difficulty of diagnosis, and the marked variation in prognosis, depending on the site of the disease. The difficulty of diagnosis is partially explained by the concep-

tion of actinomycosis as a rare disease, so that it is not expected, and by the tedious task of searching through numerous sections, as well as the slow and arduous cultural requirements. A more important reason, however, is the persisting idea that cattle and grasses convey the fungus, and in consequence it is seldom looked for in city-dwellers. To illustrate how the frequency varies with the interest taken in this condition, a comparison of two ten-year periods from the London Hospital and the Royal Victoria Hospital is as follows:

	<i>London Hospital</i>	<i>Royal Victoria Hospital</i>
1902 to 1912	14 <sup>18</sup>	31 <sup>21</sup>
1926 to 1936	103 <sup>19</sup>	9

An even more marked decrease in the number of cases has occurred at the Massachusetts General Hospital in Boston, where the work of Homer Wright and Lord had resulted in more cases being recognized there than in any other state in the Union, up to 1925.<sup>20</sup>

The three common sites of infection in the human body show marked differences in results. The cervico-facial type is the most common and gives by far the best prognosis:

	<i>London Hospital</i>	<i>Royal Victoria Hospital</i>
Male .....	34	22
Female .....	20	9
Total .....	54	31
Mortality .....	0	2

One of these fatal cases has already been reported by McKenty, in his paper reviewing all the cases at the Royal Victoria Hospital up to 1913, and the other is reported below.

The abdominal cases show a much greater mortality. In 35 cases at the London Hospital, 16 died, 15 survived, 2 were untraced, and 2 were too recent to be suitable for inclusion; while of 20 cases at the Royal Victoria Hospital, 12 died. A more accurate prognosis, however, may be obtained by dividing the cases into three clinical groups:<sup>22</sup> *Group 1.* Those resembling acute appendicitis; but a residual abscess and/or fistulae may develop subsequently. *Group 2.* A mass in the lower abdomen, with no obstruction. *Group 3.* Rapid extension by retroperitoneal cellular planes, which can be recognized by the presence of a flexed thigh.

At the Royal Victoria Hospital there were 5 cases in Group 1, all of which have done well; one of them is reported below. In Group 2 there were also 5; 2 died, and 3 were cured—all of these being in the left iliac fossa. Of the

10 cases in Group 3 all died. Thus by careful observation cases in the first group will be noted, and a favourable prognosis may be given; while in the third group the danger signal of a flexed thigh warns of a grave outcome. This leaves only a small proportion of cases where the result is doubtful.

The thoracic cases have by far the poorest prognosis, and in most published figures the mortality approaches 100 per cent. At the Royal Victoria Hospital, of 7 patients, 5 died, one is untraced, and one, whose record is reported below, has returned to work.

The following 3 cases have been selected not only because they illustrate some of the principal features of actinomycosis but also for some interesting individual peculiarities.

#### CASE 1

W.P., aged 46, a broker.

He was quite well until June, 1938, when he developed a chill and fever after a game of tennis at his country house, where it was his hobby to breed horses and cattle. In July, pain occurred in the right upper jaw, radiating to the mid-line posteriorly. After an x-ray of the right upper molars, one was removed under gas. Three days later the pain increased, accompanied by stiffness of the jaw and a fullness of the right side of the face. Five days after Dr. Young admitted him to the Royal Victoria Hospital on August 10th, spontaneous opening of a peritonsillar abscess occurred, which continued to discharge until the end of September, when the discharge diminished rapidly, to be replaced by pain in the jaw and trismus, usually worse after meals. No bacteriological examination was made at this stage. Meanwhile, about the first of September, the patient complained of diplopia, and he was found to have paralysis of the right external rectus muscle of the eye. At the beginning of October a swelling of the right lower temporal region suddenly developed, immediately above the zygomatic arch, which was only moderately tender to pressure. This swelling slowly increased in size and was aspirated, and the fluid cultured.

Other investigations included an x-ray of the skull on October 20th, which suggested osteomyelitis involving the right side of the basi-sphenoid and extending forward to the pterygoid region. Much of the abnormal bone appeared to lie in very close relationship to the cavernous sinus on the right side.

Two days later a sub-temporal abscess, which extended below the periosteum over the temporal bone, was incised and drained. The pus was obviously arising from beneath the periosteum of the floor of the skull, and Dr. Penfield judged that the origin was mesial to the pterygoid process. Culture of the pus produced a pure, heavy growth of anaerobic actinomycetes, which gave the first clue to the cause of an otherwise puzzling condition. On October 29th sulfanilamide, gr. x, every four hours, was started, and continued for four weeks. On November 18th a sub-parotid abscess, which had been developing for three weeks with pain and swelling of the right cheek, was opened and drained. From behind the ascending ramus of the mandible in the region of the parotid gland a thimbleful of brown flaky pus was obtained, and from this were grown very large numbers of anaerobic actinomycetes. An x-ray was taken on November 23rd, and suggested that the destructive process involving the basi-sphenoid was extending.

At this time the patient's general condition was quite good. He complained of indigestion and swelling of the right side of the face. The two wounds, only

slightly painful when dressed, were draining well, as was the peritonsillar sinus. He was nervous, moderately deaf in both ears, especially the left, but able to walk for about an hour a day. The sulfanilamide was discontinued and potassium iodide instituted, beginning with gr. x, three times a day. An encephalogram taken on November 25th showed that the process which partially destroyed the basi-sphenoid did not extend backwards to any appreciable extent into the skull in the region of the cisterna pontis or the inter-peduncular cistern. In view of this localization it was considered that drainage of the sphenoidal sinus might prevent further extension into the base of the skull and might avert meningitis, which otherwise was inevitable, and that thymol dressings locally might be efficacious, as his indigestion prevented large doses of iodides and x-ray treatment was of doubtful value, especially at such a depth.

On November 26th Dr. McNally operated, using the right lateral nasal approach to the sphenoidal sinus, which gave a good view of the basi-sphenoid; the bone in this area was softer than normal and appeared to be definitely diseased. However, no free pus was found. Sodium iodide was given intravenously until the patient was able to take potassium iodide by mouth. His general condition improved for a time, but he gradually became irritable again and so, after one week, iodides were discontinued, to be replaced by deep x-ray therapy on December 8th. About this time numbness of the left side of the face developed and slowly progressed; he became quite deaf, with nervousness and exhaustion following the x-ray treatments. He complained of a heavy sensation between the eyes and of feeling cold. The wounds on the face healed, but there was increased discharge from the nose. Puffiness of the right side of the face appeared on December 18th, and, although no definite increase of the destructive process of the base of the skull could be demonstrated by x-ray, it was considered advisable to explore the right sphenomaxillary fossa. Partial removal of the pterygoid bone was carried out, but revealed no pus nor definitely diseased bone. The pathological examination showed inflammatory fibrous tissue, while cultures gave no actinomycetes, and a heavy growth of *Staph. pyogenes* and pneumococci, type 21.

Shortly after Christmas he became confused and partially paralyzed, with delirium, due to developing meningitis, which continued into cerebral compression and complete coma. On January 4, 1939, right subtemporal craniotomy and exploration was carried out. There was greatly increased pressure in the ventricles until puncture of the inferior horn was performed, and pus containing actinomycetes was recovered from the interpeduncular space. Cultures of the ventricular fluid, the cerebrospinal fluid, and the blood were negative, while that from the interpeduncular cistern was positive, and smears showed definite phagocytosis of actinomycetes. The patient died a week later of circulatory failure.

The post-mortem findings were: actinomycotic meningitis; actinomycotic osteomyelitis of the skull involving the basi-sphenoid, basi-occiput, and right petrous ridges; actinomycotic inflammatory changes in the environs of the right pterygoid fossa.

**Comment.**—This was a cervico-facial case which began with a tooth-extraction, and progressed upwards to the base of the skull by direct spread, until meningitis caused a fatal ending, which is unusual in the cervico-facial type. No connection between his hobby of breeding animals and his infection was proved. There had been marked extension of the disease before the cause was recognized, at which time comprehensive treatment was carried out, the surgery being as extensive as possible. The other forms

of treatment included administration of sulfanilamide, which had no effect; potassium iodide was not used sufficiently long for accurate appraisal; blood transfusions from cases of healed actinomycotic patients were also given; the vaccine prepared according to Neuber's<sup>23</sup> method was tried, but none of the reactions for successful treatment could be elicited. This was due, no doubt, to the fact that it was not started until after the development of meningitis. Professor Murray's report states:

"Agglutination: the serum causes very fine flocculation of the antigen in a dilution of 1:5 and not in 1:10 and higher dilutions. It is slow in appearing (48 hours).

"Complement fixation: A completely controlled titration was done, using four quantities of patient's serum from 0.5 c.c. to 0.05 c.c. and two strengths of complement, 3 M.H.D. and 1.5 M.H.D. very carefully titrated. Partial fixation was obtained with 0.5 c.c. of patient's serum and 1.5 M.H.D. of complement. All other combinations gave complete hemolysis. As a very powerful antishoop hemolysin was used the actual quantity of complement available for fixation was small and free complement was readily detected. The test, therefore, was stringent.

"These examinations indicate the production of only a just perceptible amount of antibody. It cannot be said whether this is due to the prolonged infection or the vaccine since no titration was done before giving the vaccine."

#### CASE 2

J.J., aged 27, a bank clerk, was admitted to the Royal Victoria Hospital in March, 1938, under Dr. Armour, complaining of three persistent sinuses in the right iliac fossa, which had developed after an appendectomy sixteen months previously at the Hotel-Dieu. A sinus had appeared shortly after healing of the operative wound, and attempted excision of the fistulous tract had been unsuccessful. He was quite well otherwise. On examination with lipiodol the sinus was found to pass downwards and medially for 6 cm.; it was of small calibre and no loops of gut were outlined. A barium enema showed an irregular outline of the margin of the caecum, and this part did not fill. There was narrowing of the distal loop of the ileum for 5 cm. from the ileocaecal valve. Fluoroscopic examination showed many contractions of the distal loop of ileum, which descended into the pelvis near the pool of lipiodol from the sinus. The whole colon was spastic, and, after emptying, the distal loops were still very irregular. An x-ray diagnosis of regional ileitis was made; but culture of the scrapings from the sinus showed anaerobic actinomycetes. Potassium iodide treatment was started, gradually being increased to 300 grains daily. By September the wound had remained closed for three months, and the patient was back at work. In May of this year (1939) he was still well.

**Comment.**—Case 2 is included for three reasons. The x-ray diagnosis of regional ileitis suggests a comparison between this syndrome and actinomycosis, the similarity in the description of each being most striking. In fact, it seems that actinomycosis may be a factor in some cases of regional ileitis of the fistulous group. The complete failure to find the causative organism in this disease may be partly explained

by the belief in the rarity of the ray-fungus, which should be sought for more energetically. Secondly, the recognition of actinomyces in appendiceal lesions would markedly increase the number of cases belonging to Group 1, and add to our knowledge of the etiology of abdominal cases. Thirdly, the efficacy of iodide therapy is illustrated.

### CASE 3

A. McK., aged 34, a printer, was admitted to the Montreal General Hospital in 1920, complaining of a lump in the right breast. This was diagnosed clinically as carcinoma. The right pectoral muscle with the nipple was excised, and an abscess was found under the muscle, extending into the axilla. It was considered to be an empyema necessitatis, but no communication with the pleura could be demonstrated. The abscess was drained and the cultures were sterile. Pathological section showed inflammatory changes, while no tubercle bacilli could be found. Several weeks later bone appeared in the wound, and at a second operation the third rib was burred in several places. After this the wound gradually healed in a few weeks. The patient remained quite well until March, 1937, when he felt depressed. In August of the same year a tender swelling appeared between the shoulder blades, and when it was lanced pus was obtained. He was then referred to the Royal Victoria Hospital outpatient department with a large fluctuating swelling about 4 inches in diameter. From this a small wound was discharging thin greenish pus. There were no granules in the pus, and x-rays of the chest and vertebrae revealed slight bony involvement of the third rib posteriorly.

The man was admitted to the ward under the care of Dr. C. A. McIntosh, and on October 5th the abscess was thoroughly explored. No deep communication nor anterior extension could be found under the right scapula. No organisms were found on smears nor grown on cultures. At a second operation a month later, a recent anterior right thoracic sinus in the site of the original wound was explored and found to extend up to the second rib and involve the pleura at this point. Portions of the second and third ribs were removed and the wound was packed with gauze. No organisms were found on smears and only a few *Staph. epidermidis* were grown on culture. It was only at the time of the third operation on November 24th, when a small abscess on the back of the neck was opened, that the fungus could be demonstrated. No organisms were found on smears of the pus, while a moderately heavy growth of actinomyces was obtained from the tissue of the abscess wall. Sections also showed actinomycosis.

In the middle of December two small abscesses were drained, one on the chest anteriorly and the other on the left side of the neck. As well as the operative drainage of abscesses, he received, from December 1st onwards, potassium iodide by mouth in increasing doses, until during January, 1938, he was taking 400 gr. daily. In April this was reduced to 300 gr. daily. The granulating wounds were slowly healing when he went home, but he returned three weeks later slightly worse. Granules were then noticed for the first time, so the dose was increased again to 400 gr. daily. His improvement was slow, and in August he was re-admitted for sulfanilamide treatment. He was given gr. x every four hours for a week, then had five days' rest, following the procedure recommended by Walker.<sup>24</sup> His weight at this time was 100 lbs., and he had pain in the right shoulder, profuse discharge from the sinuses, and was feeling depressed. The dose of the drug was increased to 20 gr. every four hours, and the blood concentration rose from 3.9 mg. per cent on August 6th to 18.15 mg. per cent on September 17th, when the dose was reduced to 15 gr. every four hours, which maintained the level at 10 to 12 mg. per

cent. During this time he gained 15 lbs. in weight, pain was relieved, and only three small sinuses remained.

X-ray treatment was used eight times, but was discontinued as the patient became uncomfortable, slight anemia developed, and no appreciable benefit accrued. The sinuses healed, and all medication was discontinued. In February of this year the anterior wound re-opened, and a month later, when this was granulating well, the posterior wound began discharging. A new preparation of sulfanilamide (promin) was tried, 9 capsules daily, resulting in slight improvement. In June, vaccine treatment was started, but as yet it is too early to say what effect this will have. It is, however, a suitable chronic case, and it is still our hope to heal these stubborn wounds.

*Comment.*—Case 3 is reported to show how long it may be before the causative organism can be demonstrated. Only after the third attempt, when the wall of the abscess was both cultured and sectioned, was the fungus seen, and even then the pus was sterile and contained no granules. Later, however, with large doses of iodides, granules did appear. Surgical treatment has been used to aid the drugs and other methods, which seem to be slowly overcoming the infection. The source of this infection is untraceable; there is no proof that the earlier history has any bearing on his present condition, but the reappearance of a sinus in the site of his original pectoral scar, as well as the pleural involvement, is suggestive of a pulmonary origin. His living conditions are poor, and the infection may have been acquired at any time. The teeth have never shown any recognizable actinomycosis. Sulfanilamide and promin made a definite improvement in his general condition, while potassium iodide even in massive doses was of only moderate value. This may be due to the type of organism, which has not yet been finally classified.

### BACTERIOLOGICAL SUMMARY

#### Case 1.—Anaerobic actinomycosis.

This organism was sent to Dr. E. W. Emmons, Senior Mycologist of the U.S. Public Health Service, and identified by him as *A. bovis*. A culture was also sent to Dr. H. A. Dideus, of the Centraalbureau voor Schimmelcultures in Bearn, Holland. His reply, coupled with that of Prof. E. Baldacci, of the University of Pavia, is *Cohnistrepthrix Foersteri*.

#### Case 2.—Anaerobic actinomycosis of the Wolff-Israel type.

#### Case 3.—Anaerobic microaerophilic actinomycosis. Identification not yet complete.

Until a more universally accepted classification by bacteriologists is available clinicians will have to be content with the presence or absence of the

ray-fungus, and call the disease "actinomycosis". The appropriate drug or vaccine, however, will have to be determined in each individual case.

The many forms of treatment testify to the inefficiency of any one type of therapy. Of the drugs, potassium iodide in moderate to large doses, *i.e.*, 150-300 grains daily, is still the main stand-by. Sulfanilamide was used in two cases—the first showed definite improvement in his general condition, but in the other there was no observable effect. This corresponds with other reports, and the conflicting accounts may perhaps be explained by peculiarities of the strain, as well as by the concomitant infection present, *e.g.*, in Case 1, where there was a mixed infection with staphylococci, and the drug had little or no effect, whereas in Case 3, with an unusual strain of anaerobic actinomyces, the improvement was appreciable.

#### CONCLUSIONS

The pure infections appear to respond better to drugs than do the mixed ones, while it seems possible that the various strains of actinomyces react differently to the same drug. Surgical treatment is imperative in nearly all cases. Where complete excision is possible it should be carried out, but unfortunately this is seldom practicable. In such cases incision and drainage of all abscesses is indicated, combined with such other treatment as may seem best suited to the case. The prognosis varies enormously with the site affected, and a similar variability is observed

in the three clinical groups of abdominal infection. Lastly, in all suspicious cases, early and diligent search for the ray-fungus should be undertaken and the abscess wall cultured when the pus is sterile, as it is apparent from the figures presented that interest in this condition and the number of cases found are directly proportional.

My thanks are due to the members of the staff already mentioned for permission to report these cases, to the Department of Bacteriology for their helpful co-operation, and especially to Dr. W. G. Stewart who is working on a classification of these organisms. Finally, I wish to thank Dr. E. W. Archibald and Prof. E. G. D. Murray for their valuable advice.

#### REFERENCES

1. MOODIE, R. L.: *J. Parasitol.*, 1922-3, 9: 28.
2. BOLLINGER, O.: *Centr. f. d. med. Wissensch.*, 1877, 15: 481.
3. WOLFF, M. AND ISRAEL, J.: *Archiv. f. path. Anat.*, 1891, 126: 11.
4. BELL, J.: *Montreal Med. J.*, 1905, 34: 81.
5. LIGNIERES, J. AND SPITZ, J.: *Bull. de la Soc. cent. de méd. vét.*, 1902, p. 487.
6. KLINGER, R.: *Centralbl. f. Bakteriologie*, orig., 1912, 62: 191.
7. NAESLUND, C.: *Acta path. microb. Scand.*, Supp. 6, 1931.
8. COPE, Z.: *Actinomycosis*, Oxford Med. Publications, Oxford University Press, 1933.
9. TOPLEY, W. W. C. AND WILSON, G. S.: *Principles of Bacteriology and Immunity*, Arnold, Lond., 1936, p. 269.
10. COLEBROOKE, L.: *Proc. Roy. Soc. Med.*, 1930, 23: 861.
11. BOESTROM: *Beitr. z. path. Anat.*, 1890, 9: 1.
12. ERIKSON, D.: *Med. Research Council, Spec. Report*, Series No. 203, 1935.
13. ISRAEL, J.: *Langenbeck's Arch. f. klin. Chir.*, 1887, 34: 160.
14. JUDD, W. R.: *Brit. M. J.*, 1926, 2: 886.
15. COPE, Z.: *Brit. J. Surg.*, 1915, 3: 55.
16. NAESLUND, C.: *Dental Cosmos*, 1926, 68: 1137.
17. *Idem*: *Acta path. microb. Scand.*, 1926, 3: 637.
18. HASSEGAWA *et al.*: *Jap. J. Med. Sci.*, v. Path., 1938, 3: 28.
19. SOUTTAR, H. S.: *Roy. Soc. Med.*, 1912, 6: 151.
20. DONALD, C.: Personal communication.
21. SANDFORD, A. H. AND VOEKER, M.: *Arch. Surg.*, 1925, 11: 809.
22. MCKENTY, F. E.: *Am. J. Med. Sci.*, 1913, 145: 835.
23. WILLIAM, G.: *Proc. Roy. Soc. Med.*, 1912, 6: 145.
24. NEUBER, E.: *Wien. klin. Wchnschr.*, 1932, 45: 357; *idem*, 1937, 50: 1176; *idem*, 1938, 51: 358.
25. WALKER, O.: *The Lancet*, 1938, 234: 1219.

### EYE SIGNS IN INTRACRANIAL DISEASE\*

By R. J. P. McCulloch

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THE average day in an oculist's life is spent in considering errors of refraction and in the diagnosis and treatment of diseases of the eye. The routine steps in an eye examination tend to focus his thoughts on the eye alone, and it seems wise periodically to review his relationship to medicine as a whole. The patient when consulting an oculist knows that he is consulting a physician and has the right to expect that the signs and symptoms found will be evaluated

in the interests of his general welfare as well as from the standpoint of his eyes alone.

I am, for this period, directing your attention to our relation to neurology. I am doing so since I have to confess that I have made many humiliating blunders in this field because I have been blind to the implications of certain symptoms or findings which should have turned my thoughts in the proper direction.

For example, a patient consulted me for a troublesome irritation and watering of one eye. She was treated for follicular conjunctivitis, but the watering and irritation remained. An

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